Method of Test for
THEORETICAL MAXIMUM SPECIFIC GRAVITY OF ASPHALTIC CONCRETE MIXTURES
DOTD Designation: TR 327

I. Scope

A. This method of test determines the theoretical maximum specific gravity and density of uncompacted bituminous paving mixtures at 25°C.
B. Reference Documents
   1. DOTD S 201 – Sampling Asphaltic Materials
   2. DOTD S 203 – Sampling Asphaltic Mixtures.
   3. DOTD TR 108 – Splitting and Quartering Samples
   4. AASHTO Designation: T209

II. Apparatus

A. **Pycnometer** – A thick wall metal vacuum bowl with a tight fitting metal lid with a capillary bore to allow air and excess water to escape. Capacity of approximately 4500 mL. Additionally, a transparent vacuum lid with a vacuum fitting is required for observation of bubble release during testing. (Meets requirements of AASHTO T209, Type E)
B. **Balance** – A balance having a capacity of 16,000 g or more and sensitive to 0.1 g.
C. **Water Bath** – capable of maintaining a constant temperature between 20 to 30°C (68 to 86°F).
D. **Metal pan** - capable of containing 5000 g of asphaltic material.
E. **Metal work surface**
F. **Thick "kraft" paper** *(optional)*
G. **Non-stick cooking spray** (Pam or approved equal).
H. **Wetting Agent** – Aerosol OT in a concentration of 0.2 grams in 20 L of water or Sodium Hexameta Phosphate at 15 grams in 4500 mL of water. **Oven** – A constant temperature oven capable of maintaining temperatures within the range of 40±3°C to 200±3°C (100±5°F to 400±5°F).
I. **Vibratory table** – capable of holding pycnometer securely.
J. **Vacuum pump and manometer setup** – See Figure 1.
K. **Timer**
L. **Small Fan** – for cooling mixture *(optional)*
M. **Thermometer** – range of –1 to 82°C (30 to 180°F) sensitive to 0.5°C (1°F)
N. **Miscellaneous** – Gloves, spatula, trowel, paper towels, water bottle.
O. **Worksheet** – Theoretical Maximum Specific Gravity Worksheet (03-22-3095), Asphaltic Concrete Plant Report or Superpave Asphaltic Concrete Plant Report. (Figure 2)

Figure 1: Vacuum Pump and Manometer Setup

III. Sample

A. Obtain a minimum 6000 g sample.
   1. Asphaltic Concrete – from the haul truck obtain a sample in accordance with DOTD S 203.

2. Reclaimed Asphaltic Concrete Pavement (RAP) – from the stockpile obtain a sample in accordance with DOTD S 101.

B. If the sample is not soft enough to separate with a spatula or trowel, place the material in an oven at 160±5°C (320±9°F) until a proper level of workability is obtained.

C. Quarter the sample, in accordance with DOTD TR 108, to obtain a specimen conforming to the following requirements. For specimen sizes greater than 3500 g, quarter the specimen into two approximately equal representative portions. Label each portion as "sample a" and "sample b" respectively.

Nominal Maximum Size Aggregate in Mix, in. (mm)	Minimum Sample Size, g
2 (50.0)	6000
1 ½ (37.5)	4000
1 (25.0)	3000
¾ (19.0)	2000
½ (12.5)	1500
3/8 (9.5)	1000
No. 4 (4.75)	500

D. Spray a light coating of non-stick spray into the pan.

E. Place the specimen into a pan and return to the oven for a minimum period of two hours for lab-produced mixtures and one hour for plant-produced mixtures or reclaimed asphaltic concrete.

Note 1: *For mixtures containing aggregates with water absorption values greater than 2%, the oven aging time for plant-produced mix shall be increased to 2 hours.*

IV. Calibration of Pycnometer

A. Overfill the pycnometer with water or carefully submerge in water at 25±0.5°C (77±1.0°F).

B. Evenly place metal lid on the pycnometer, exerting gentle pressure that will force excess water to escape through the capillary bore, preventing any air from being entrapped under the lid.

C. If applicable, remove from the water bath and completely dry the outside of the pycnometer.

D. Weigh the pycnometer filled with water.

E. Record on the worksheet, the "Weight of Pycnometer and Water," **D**, to the nearest 0.1 g.

V. Procedure

A. Remove the representative portion and pan from the oven.

B. Empty the representative portion onto metal surface, sprayed with a light coat of non-stick cooking spray, or a sheet of thick kraft paper to cool. Scrape pan with a spatula or trowel, spreading residue over the sample. A fan may be used to facilitate cooling.

C. While sample is cooling, separate the particles of the representative portion by hand so that any conglomeration of fine aggregate particles are not larger than 6.3 mm (1/4 in.). If the representative portion is not sufficiently soft to be separated manually, place it in a flat pan, and warm it in an oven until it can be separated as described.

D. Cool sample to room temperature.

E. Weigh cooled representative portion on a balance and record as "Weight of Mix," **A**, to the nearest 0.1 g.

F. Place the representative portion into calibrated pycnometer. Add sufficient water at a temperature of 25±0.5°C (77±1.0°F) to cover sample completely.

Note 2: *For assistance with dissipation of foam, floating particles and entrapped air a suitable wetting agent, such as Aerosol OT in concentration of 0.2 grams in 20 L of water, may be added to the water.*

G. Place pycnometer with representative portion and water on the vibratory table.

H. Place transparent vacuum lid on pycnometer. Secure with screws located on the vibratory table.
I. Attach the vacuum hose from the manometer to the transparent vacuum lid.
J. Turn on vibratory table.
K. Turn on vacuum pump until manometer reads 30 in. of Hg (Mercury). When the vacuum reaches 30 in. of Hg, vacuum for 15±2 minutes. Complete Steps L through S within 10 minutes of completion of this vacuum period.
L. Turn off pump and vibrating table at the end of the vacuum period.
M. Slowly open release valve on the vacuum lid to slowly equalize pressure.

Note 3: **Caution:** *Opening valve too quickly can cause loss of material and damage to euipment.*

N. Once the pressure is equalized, remove the pycnometer from the vibratory table.
O. After removal of the pycnometer from the vibratory table, remove the transparent vacuum lid.
P. Overfill the pycnometer with water or carefully submerge in water bath, maintained at 25±0.5°C (77±1.0°F), assuring that the final temperature of the water in the pycnometer is 25±0.5°C (77±1.0°F).

Note 4: *If a wetting agent is used, the pycnometer may not be submerged due to contamination of the water in the bath.*

Q. Evenly place metal lid on the pycnometer, exerting gentle pressure that will force excess water to escape through the capillary bore, preventing any air from being entrapped under the lid.
R. If applicable, remove from the water bath and completely dry the outside of the pycnometer.
S. Weigh the pycnometer containing representative portion and water. Record weight as "Weight of Pycnometer, Water & Mix," **E**, on the worksheet to the nearest 0.1 g.
T. Calculate the Theoretical Maximum Specific Gravity in accordance with Step VI.A.
U. If required, repeat Steps A through T, for "sample b" and average the results obtained in Step T for each portion in accordance with Step VI.B.

Note 5: *When due to the required size of the representative portion, two separate tests are run; the difference between the theoretical maximum specific gravity of each split portion shall not exceed 0.015. If this occurs, a new sample shall be obtained and the test procedure repeated.*

V. Report the Theoretical Maximum Specific Gravity as $\mathbf{G_{mm}}$.

VI. Calculations

A. Determine the theoretical maximum specific gravity (G_{mm}) of each part of the sample as follows:

$$G_{mm} = \frac{A}{A + D - E}$$

where,

A = weight of mix
D = weight of pycnometer and water
E = weight of pycnometer, water and mix

Example:

A = 2069.8 g
D = 7513.6 g
E = 8755.0 g

$$G_{mm} = \frac{2069.8}{2069.8 + 7513.6 - 8755.0}$$

$$= \frac{2069.8}{828.4}$$

$$= 2.49855$$

$$G_{mm} = 2.499$$

B. If two representative portions were run, determine the Theoretical Maximum Specific Gravity in accordance with the following equation:

$$G_{mm} = \frac{G_{mm\,a} + G_{mm\,b}}{2}$$

where,

$G_{mm\,a}$ = Theoretical Maximum Specific Gravity of "sample a"
$G_{mm\,b}$ = Theoretical Maximum Specific Gravity of "sample b"

Example:

$G_{mm\,a} = 2.499$
$G_{mm\,b} = 2.508$

$$G_{mm} = \frac{2.499 + 2.508}{2}$$

$$= \frac{5.007}{2}$$

$$= 2.50350$$

$$G_{mm} = 2.504$$

VII. Report

Report the Theoretical Maximum Specific Gravity (G_{mm}) to the nearest 0.001.

VIII. Normal Test Reporting Time

Normal test reporting time is 4 hours.

MATT MENU SELECTION - 09

DOTD 03-22-3095
05/03

Louisiana Department of Transportation and Development

THEORETICAL MAXIMUM SPECIFIC GRAVITY (G_{mm})
(DOTD TR 327)

Project No. |_|_|_|-|_|_|_|-|_|_|_|

Date Rec'd. ______________________

Material Code |_|_|_|

Lab No. |_|_|_|-|_|_|_|_|_|_|_|

Date Sampled 03-11-03

Submitted By 0582

Quantity |_|_|_|_|_|_| **Units** |_|_|_|

Purpose Code 1

Plant Code H914

Spec. Code 3

P O No. |_|_|_|_|_|_|_|_|

Date Tested 03-12-03

Ident. |_|_|_|_|_|_|_|

Remarks 1 |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|

Remarks 2 |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|

Item No. 502

Sampled By: G. Smith Date: 3/11/03

	TEST RESULTS	P/F
JOB MIX FORMULA SEQUENCE NO.	037	XXXX
LOT NUMBER	1100	XXXX
MIX CODE	04	XXXX
PLANT TYPE	3	XXXX

1 = Batch Screenless 2 = Batch Hot Bin
3 = Drum Mixer 4 = Continuous

THEORETICAL MAXIMUM SPECIFIC GRAVITY, G_{mm} "RICE" *(DOTD TR 327)*			
		G_{mm}	
		Sample a	Sample b*
Wt of Mix	A	2069.8	2105.2
Wt of Pyc. & Water	D	7513.6	7513.6
Wt of Pyc. Water & Mix	E	8755.0	8779.4
Difference	A + D - E	828.4	839.4
G_{mm}	A / (A + D - E)	$G_{mm}a$ 2.499	$G_{mm}b$ 2.508
$G_{mm} = (G_{mm}a + G_{mm}b) / 2$		* *Sample b required only when designated by DOTD TR 327.*	

THEORETICAL MAXIMUM SPECIFIC GRAVITY (G_{mm}) .... 2.504 XXXX

Tested By: A. Technician Date: 3/12/03

Checked By: T. Mann Date: 3/12/03

APPROVED BY: D. L. Engineer **Date:** 3/13/03

Figure 2
DOTD 03-22-3095
Theoretical Maximum Specific Gravity (G_{mm})